SENSIRION
THE SENSOR COMPANY

Application Note for I²C Flow and Differential Pressure Sensors
Read Temperature and Supply Voltage

Summary

Sensirion I²C sensors measuring flow or differential pressure are based on the same thermal flow sensor chip, called SF04. This chip offers to read out the temperature.

This application note explains how to read out the temperature.

1. Read out temperature and Supply Voltage

On the surface of the sensor chip, a bandgap temperature sensor is placed. This sensor, reading the temperature of the gas over the sensor chip, can be read out. Also included on the chip is a bandgap voltage reference, which allows to measure the supply voltage.

A measurement is invoked using the following command.

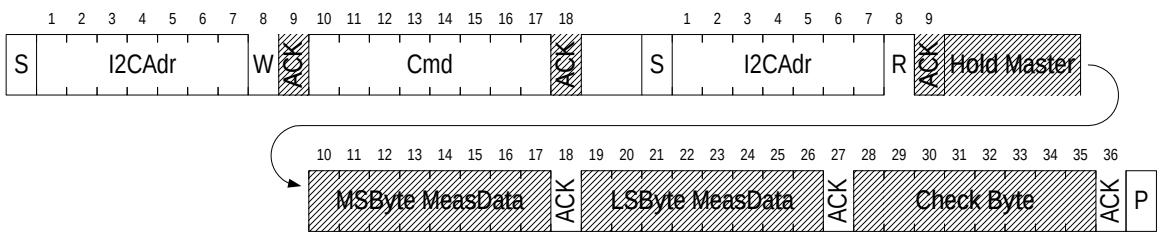
8 Bit Command Code	*Command*
hF3	trigger temperature measurement
hF5	trigger VDD measurement

Trigger Measurement

For basic sensor communication, please refer to the product datasheet or the user manual "I²C functional description".

The illustration below shows the communication sequence for a measurement command. Upon reception of the header with R/_W=1, the sensor system produces the hold-master condition on the bus until the first measurement is completed. Once the hold-master condition is suspended, the master can read the result as two consecutive bytes. A CRC byte follows if the master continues clocking the SCL line after the second result byte. The sensor system checks whether the master sends an acknowledge after each byte and aborts the transmission if not. Note that two transfer sequences are needed. The first sequence stores the command, while the second sequence invokes the previously stored command in READ mode.

I²C Measurement



2. Scale/shift correction

By default, most Sensirion I²C flow and differential pressure sensors deliver raw temperature and supply voltage data. This raw data is already quite linear, but the offset and the gain may vary from sensor to sensor. In other words, invoking the above command delivers a perfectly repeatable, but not calibrated signal. There is no easy conversion to °C or V.

However, the output may be switched to a roughly corrected signal, where the offset is shifted and the gain scaled to get a temperature value in °C unit or a voltage value in V.

While the repeatability and reproducibility of the temperature measurement is state-of-the-art, most sensors feature only a very rough temperature calibration. For a more accurate calibration, please contact Sensirion.

To enable the scale/shift correction for temperature and supply voltage measurement, bit 10 of the User register has to be set. If this bit is cleared, the sensor system delivers temperature raw data. If bit 10 of the user register is set, the output is an integer value with the following scale factors.

Parameter	*Scale factor*	*Explanation*
Temperature	$10°C^{-1}$	Divide the signed output value by 10 to get the physical value in degree C.
Supply voltage	1mV ($1000\ V^{-1}$)	The output directly represents mV.

To change the setting, the following steps have to be done:

1. Read user register.
2. Define the new register entry.
3. Write the new value to the user register.

User register content

The temperature scale/shift correction is set in bit 10 of the user register, whereas bit 15 represents the most significant bit (MSB) and bit 0 represents the least significant bit (LSB).

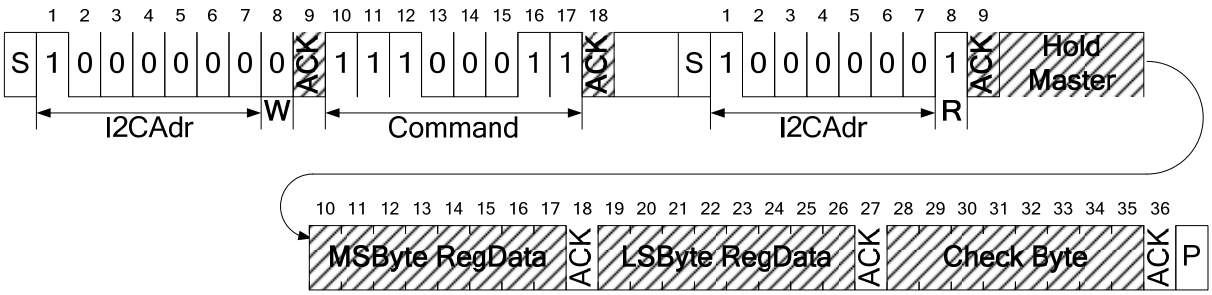
Bit number	15 MSB	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0 LSB
Default user register for most sensors (Temperature raw data mode)	x_{15}	x_{14}	x_{13}	x_{12}	x_{11}	0	x_9	x_8	x_7	x_6	x_5	x_4	x_3	x_2	x_1	x_0
	Do not change!					T-Scale/Shift.	Do not change!									
Changed user register to enable temperature scale/sift correction	x_{15}	x_{14}	x_{13}	x_{12}	x_{11}	1	x_9	x_8	x_7	x_6	x_5	x_4	x_3	x_2	x_1	x_0

Read User Register

Read the content of the user register. After the header with R/_W=1, the sensor system writes the register value to the bus. The first byte written is the most significant byte, the second byte the least significant byte of the register. A CRC byte follows if the master continues clocking the SCK line after the second byte. The sensor system checks whether the master sends an acknowledge after each byte and aborts the transmission if not. Note that two transfer sequences are needed. The first sequence stores the command, while the second sequence invokes the previously stored command in READ mode.

I²C Read Register

8-bit command code: hE3
Command: Read user register



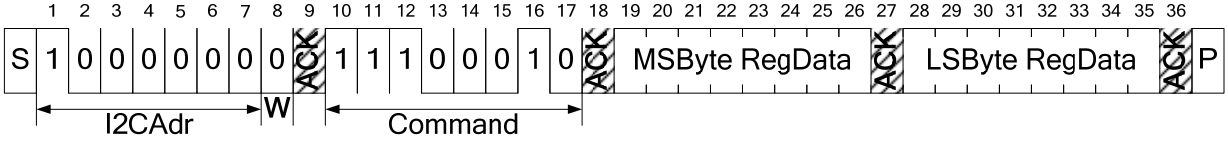
Hatched areas indicate that the sensor controls the SDA line.

Write User Register

Overwrite the register addressed by the command. After the command byte the sensor system reads the new register value from the bus. The first byte is stored as the most significant byte, the second byte is stored as the least significant byte of the register. The sensor system acknowledges successful reception of each byte (ACK)

I²C Write Register

8-bit command code: hE2
Command: Write user register

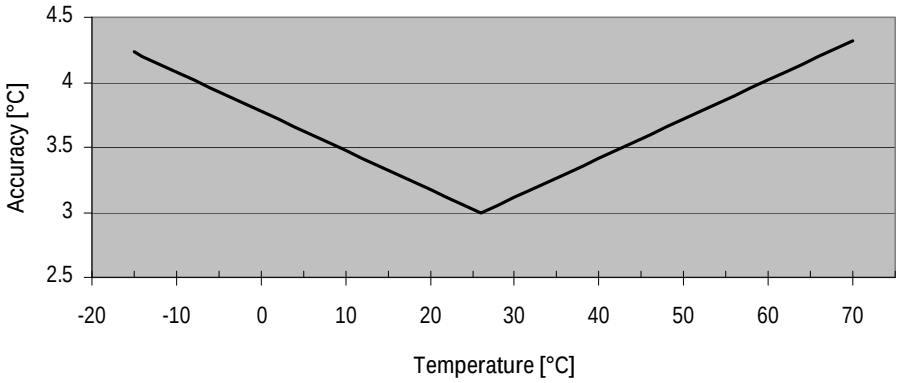


Hatched areas indicate that the sensor controls the SDA line.

Default setting

After each hard reset or soft reset of the sensor, the default settings are written to the register. When working with a different setting, the setting has to be changed after every power-on or soft reset.

3. Specification for temperature measurement

Parameter	SDP600 Series
Measurement Range	-15°C to 70°C
Digital Resolution	0.1°C
Reproducibility[1]	0.2°C
Accuracy[2]	±3°C @ 26°C
Temperature dependency[2]	±0.3°C per 10°C
Graphical illustration of accuracy[2]	

[1] The reproducibility represents the measurement spreading for multiple measurements under identical temperature and ambient conditions, including gas temperature, housing temperature and flow sensor heater power.

[2] Temperature specifications may be improved for the standard sensor in the future. For tighter temperature sensor specifications, please contact Sensirion.

4. Revision history

Date	Version	Changes
September 2009	V1.0	Initial Release

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